MAGNETIC SHIELD CORPORATION

Perfection Mica Company

740 North Thomas Drive
Bensenville, Illinois 60106-1643 U.S.A.
FAX 630-766-2813 Phone 630-766-7800
www.magnetic-shield.com
E-mail: shields@magnetic-shield.com

Zero Gauss Chambers

I Introduction

The Magnetic Shield Corporation Zero Gauss Chamber provides a work space having an extremely low magnetic field. This is achieved by high attenuation of both D.C. and A.C. magnetic fields.

Zero Gauss Chambers are fabricated from high permeability CO-NETIC AA alloy in a series of two or more concentrically spaced magnetic shields. Each magnetic shield consists of a cylinder with one closed end and a close-fitting removable cover on the other end. Of all geometric shapes, a cylindrical configuration is one of the most effective for magnetically shielding a finite space.

Each shield is magnetically isolated from the adjacent shields by nonmagnetic spacers. The multiplying effect of successive shields provides substantially greater attenuation of magnetic fields than a magnetic shield of equivalent wall thickness.

II Design Considerations

INTERIOR SIZE

The initial consideration is the interior size of the chamber. For best results, the inside chamber diameter should be as small as possible because attenuation is inversely proportional to diameter. Hence, a smaller shield is desirable because it provides greater attenuation for a given wall thickness. Additionally, the small diameter is more economical since less material is required. For practical reasons, the minimum inside diameter for a double wall chamber is 4 inches (101,6mm). For triple wall chambers, or if a degaussing coil is ordered, the minimum inside diameter is 6 inches (152,4mm).

EXTERNAL FIELD STRENGTH

Most Zero Gauss Chambers are operated in earth's field, which is usually about 0.5 Gauss. In most environments, however, there are additional sources of magnetic fields, usually 60 Hertz and its harmonics.

Since all magnetic fields around the chamber are part of the ambient magnetic field, their magnitude must be considered as part of the shielding requirements. If any of these sources are unusually strong and close to your apparatus, additional shielding may be required to prevent saturation. Even a small to moderate external field added to earth's field will raise the level of the attenuated field inside the chamber.

ATTENUATION

The number of concentric shields required is a function of the degree of attenuation desired. The external field strength and the maximum allowable magnetic field inside the chamber, or the required attenuation, are furnished by the customer.

To achieve internal magnetic fields of 10 milliGauss or less, a degaussing coil is usually required around the inner chamber to remove residual magnetism which may accumulate.

WALL THICKNESS

After annealing, CO-NETIC AA alloy is relatively soft. Consequently, the chambers must be fabricated with sufficient wall thickness to maintain the physical integrity of the assembly. The chamber must be able to support itself and provide sufficient strength to support the item being shielded. Therefore, minimum wall thickness is .025 inches (0,635mm).

ACCESS HOLES

Holes are provided in the chamber, as specified, for power and signal cables, degaussing coil leads and other items requiring access to the interior. For best results, holes should be as few and as small as possible, with their axes positioned perpendicular (transverse) to the ambient field. The minimum material distance between any two holes in a shield should be equal to the diameter of the larger hole. For construction and alignment purposes, preferred hole locations are in the closed end or in the removable covers. Holes required in the side walls of the cylinders are punched in the flat blanks prior to rolling.

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Holes in a magnetic shield will allow the interfering field to fringe into the chamber. The amount of leakage is a function of the hole size and the angle between the axis of the hole and the direction of the interference field. If the axis of the hole is perpendicular (transverse) to the ambient field, the fringing field will extend about one hole diameter into the chamber. If the axis of the hole is parallel (axial) to the interference field, the fringing field will extend about 2 hole diameters into the chamber. Items inside the chamber should be located away from holes. If this cannot be done, then leakage can be substantially reduced with cylindrical shield extensions welded or fastened onto the outer surface of the chamber assembly around the holes (see photo). These extensions will minimize fringing, and should be 1 to 2 diameters in length, depending on field orientation.

SPACERS

Each CO-NETIC shield of our Zero Gauss Chamber is magnetically isolated from adjacent shields. Spacing is accomplished with three longitudinal 1/2 inch stainless steel tubing spacers 120° apart. Closed ends are separated by 1/2 inch spacers. To facilitate removal, covers are not fastened together. The 1/2 inch spacing between covers is controlled by the different lengths of each can. Adjacent cans are typically 1 inch different in length, plus two wall thicknesses.

TOLERANCES

Our Zero Gauss Chambers are fabricated to the individual requirements of each customer, utilizing standard tooling. The full Hydrogen annealing process, essential for optimum magnetic properties, may result in some minor distortion of fabricated parts as stresses are relieved. For these reasons, we recommend that tolerances be specified no tighter than ±0.030 inch (0,762mm) or 0.5%, whichever is greater. Avoiding unnecessary tight tolerances will prevent additional cost.

OPERATING ENVIRONMENT

The final consideration is the operating environment of the Zero Gauss Chamber. Normal room conditions usually do not present any problems. High or low operating temperatures may restrict the use of plastics in the handles on the covers and the insulation in the degaussing coil. The operating range of CO-NETIC AA alloys is —452°F (—269°C) to 850°F (454°C). Operation in a vacuum will preclude use of plastics and many finishes because of outgassing.

III Chamber Construction

WELDING OF SEAMS

Standard chamber construction utilizes heliarc butt seam welds. To make a uniform full fusion joint, a strip of the parent CO-NETIC AA alloy is used as a filler rod during welding. This assures the integrity of the magnetic shielding characteristics throughout the joint. Spot welding is not recommended for Zero Gauss Chambers.

COVERS

The outside, close-fitting removable covers have a lip of 0.5 to 1.0 inch (12,7 to 25,4mm) to avoid magnetic field leakage and still allow convenient access to the chamber interior. For easy cover removal, plastic handles can be installed. As an economical alternative, each cover can be provided with a 0.875 inch (22,22mm) hole in the center to allow removal with a finger.

HOLES

Any holes in curved surfaces are punched in the flat blanks prior to rolling. Therefore, the projected view of access holes will be elliptical.

ANNEALING

After all fabrication is complete, the individual cans and covers are fully Hydrogen annealed to optimize their magnetic shielding properties. The attenuation of each can is measured before and after anneal to ensure the proper annealing cycle.

FINISH

CO-NETIC AA alloy, because of its high Nickel content, is corrosion resistant. Following an annealing cycle in a dry Hydrogen atmosphere, the material exhibits a clean, bright surface condition. Consequently, CO-NETIC alloys are usually used as annealed, without further finishing operations.

ASSEMBLY

After all other operations have been completed, the chamber is assembled. The degaussing coil, if ordered, is installed. The final assembly is tested in our Helmholtz coil for attenuation.

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IV Use

APPLICATIONS

CO-NETIC Zero Gauss Chambers have a wide range of application for scientific, industrial, and commercial users. They are used in laboratories conducting research in very low magnetic environments. Industrial uses include the production and testing of magnetically sensitive apparatus. CO-NETIC Zero Gauss Chambers are also used by commercial users of magnetically sensitive equipment to periodically calibrate their equipment.

ORIENTATION

For best results, the chamber should be oriented so that the axes of the cylinders and the axes of the holes are perpendicular to the ambient field. This position is easily determined by rotating the chamber until the level of the field within the chamber is at a minimum.

DEGAUSSING

To achieve the lowest magnetic levels within the chamber and for optimum long term stability and uniformity of the internal magnetic field levels, the periodic use of a degaussing coil is recommended. The coil is driven with sufficient 60 Hertz current to saturate the chamber. Then the current is slowly reduced so that the residual magnetism is minimized.

SHOCK AND DAMAGE

CO-NETIC AA alloy is relatively insensitive to reasonable shock. Normal handling of the Zero Gauss Chamber will not cause any significant reduction in magnetic shielding effectiveness. If the chamber receives severe shock or deformation, disassemble and re-anneal the individual cans and covers after all necessary rework is complete.

V Specifications

You are invited to call our engineering Department to discuss your design requirements and to send a sketch or description for a prompt quotation. Your drawings should include the following notes:

1. Material:
   CO-NETIC AA alloy
   Stress Annealed
   Thickness
   (See MG-7 catalog for standard thicknesses)
2. Welding:
   Heliarc butt seam weld using parent metal as filler.
3 Anneal:
   After forming and welding, but before final assembly, Hydrogen anneal for maximum permeability.
4. Source:

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Magnetic Shield....*the Preferred Source*

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